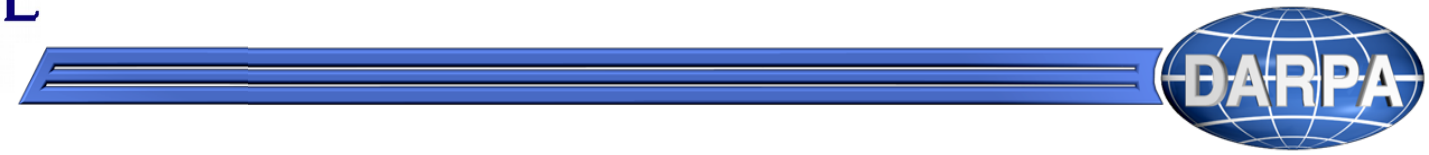

Semantic Information Fusion

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Acknowledgment / Disclaimer

This effort is sponsored by the Defense Advance Research Projects Agency (DARPA) and the Space and Naval Warfare Systems Center, San Diego (SSC-SD), under grant number N66001-00-C-8947 (Semantic Information Fusion in Scalable, Fixed and Mobile Node Wireless Networks). The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright annotation thereon. The views and conclusions contained herein are those of the author's and should not be interpreted as necessarily represent the official policies or endorsements, either expressed or implied, of the Defense Advanced Research Projects Agency (DARPA), the Space and Naval Warfare Systems Center, or the U.S. Government.

Overview – Objectives

This project addresses the severe power and processing constraints on the internetworking of mobile and fixed microsensors by devising knowledge based methods for their efficient utilization.

- Both Semantic and Principal Components are used to reduce data prior to transmission.
- Continuously self-configuring groups of sensor platforms are used to determine platform velocity along its track.
- Only vehicle class, peak times, and peak amplitudes are transmitted over a local area.
- Software implementation integrates with and contributes to program field

Major Accomplishments

1. Develop SIF based classification software
2. Verify classification software
3. Develop velocity determination software
4. Verify velocity determination software
5. Integrate into program

Improved Classification

reate a database for each class, C

Preprocessing $\{\overline{\Phi}_n\}$

Average spectral vector

$$\overline{\Psi} = \frac{1}{N}\sum_{i=1}^{N}\overline{\Phi}_i$$

Covariance matrix

$$\frac{1}{N}\sum_{i=1}^{N}\left(\overline{\Phi}_i - \overline{\Psi}\right)\left(\overline{\Phi}_i - \overline{\Psi}\right)^T$$

Principal components of covariance matrix $\overline{\Theta}_1, \ldots, \overline{\Theta}_k$

Test Databases

$\overline{\Psi}^C, \{\overline{\Theta}_i\}^C$

Preprocessing $\{\overline{\phi}_n\}$

Determine error for each class

$$\varepsilon^C = \sqrt{\sum_{i=1}^{M_r}\left(\varepsilon_i^C\right)^2} \text{ where}$$

$$\overline{\varepsilon}_n^C = \overline{\phi}_n - \overline{\Psi}^C - \sum_{k=1}^{M^C}\omega_{nk}^C\overline{\Theta}_k^C \text{ and}$$

$$\omega_{nk}^C = \left(\overline{\phi}_n - \overline{\Psi}^C\right)\cdot\overline{\Theta}_k^C$$

Select class with lowest error

Classification Results

Initial Test

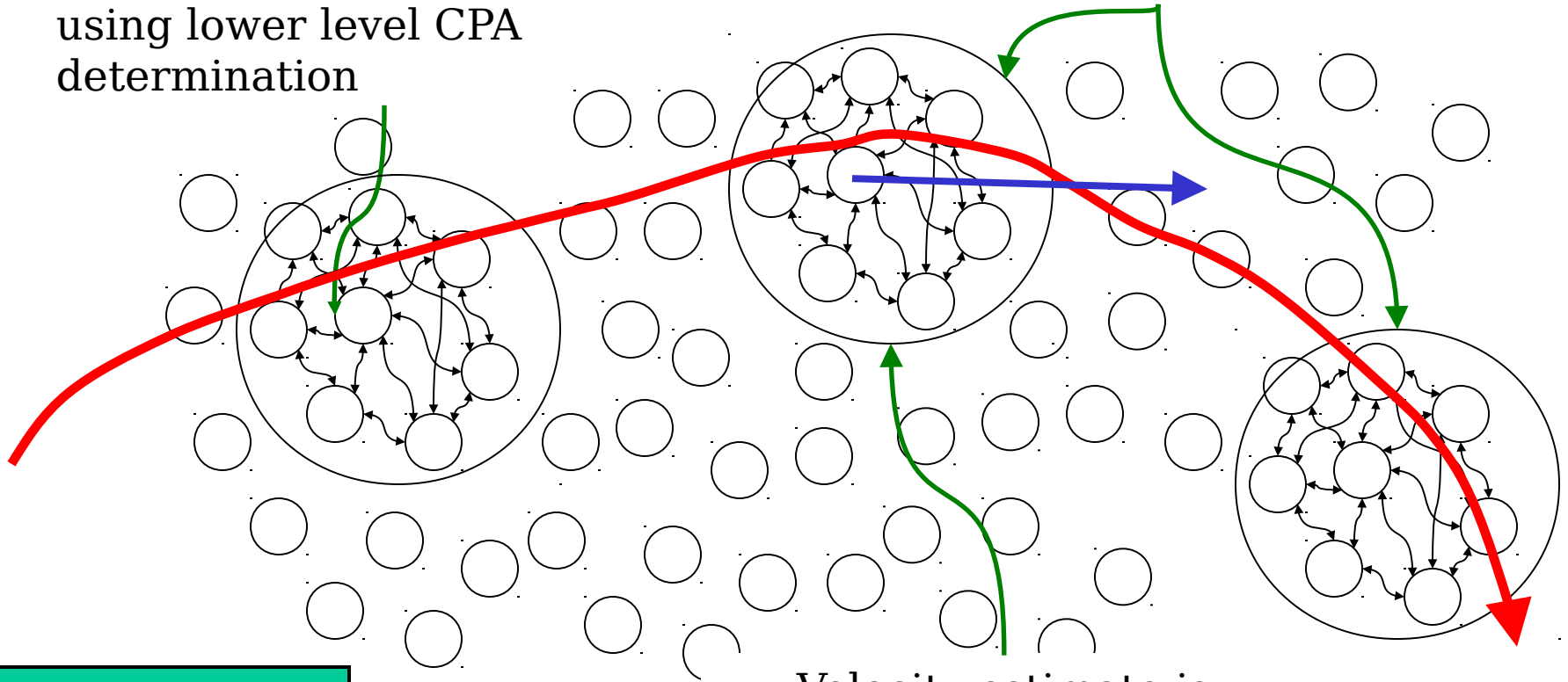
- This test was run after down-sampling the Sitex 02 acoustic data to 4 KHz to match our database of Sitex 00 high density data.
- The test database consisted of 20 tank peaks and 16 dragon wagon peaks.
- It included only 3 runs but had data from many microphones

Vehicles Correctly Id'ed:		30 (83%)
Correlation Coefficient:		0.69
True Tracked:		15 (75%)
True Wheeled:	15 (94%)	
False Tracked:	1	
False Wheeled:	5	

Collaborative Signal Processing

Time series are processed locally for target classification using lower level CPA determination

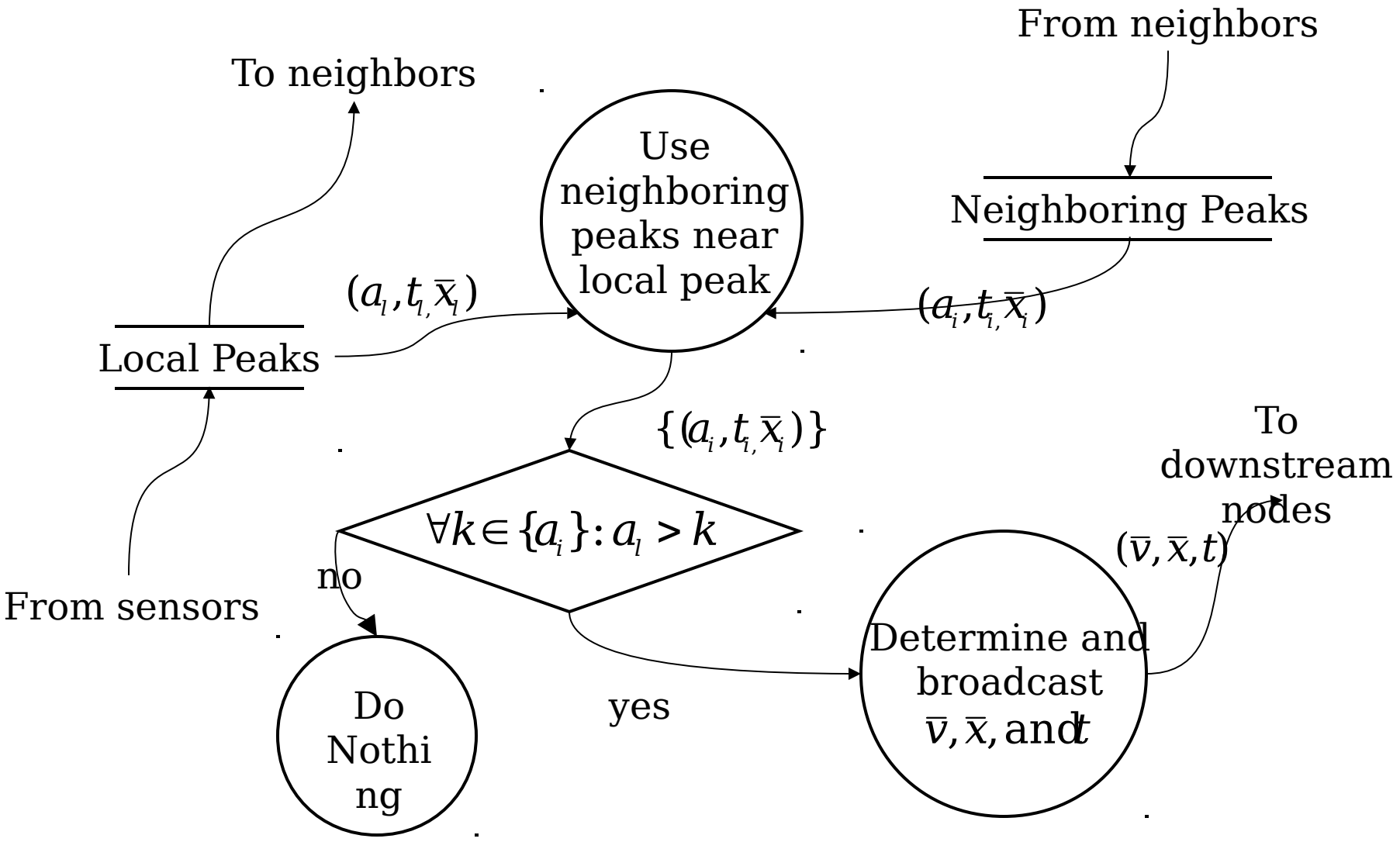
Nodes dynamically self-organize into groups along target trajectory to determine target velocity



Velocity estimate is broadcast along trajectory for tracking

Target Track
Notation
Data Sharing
Forward Target Track

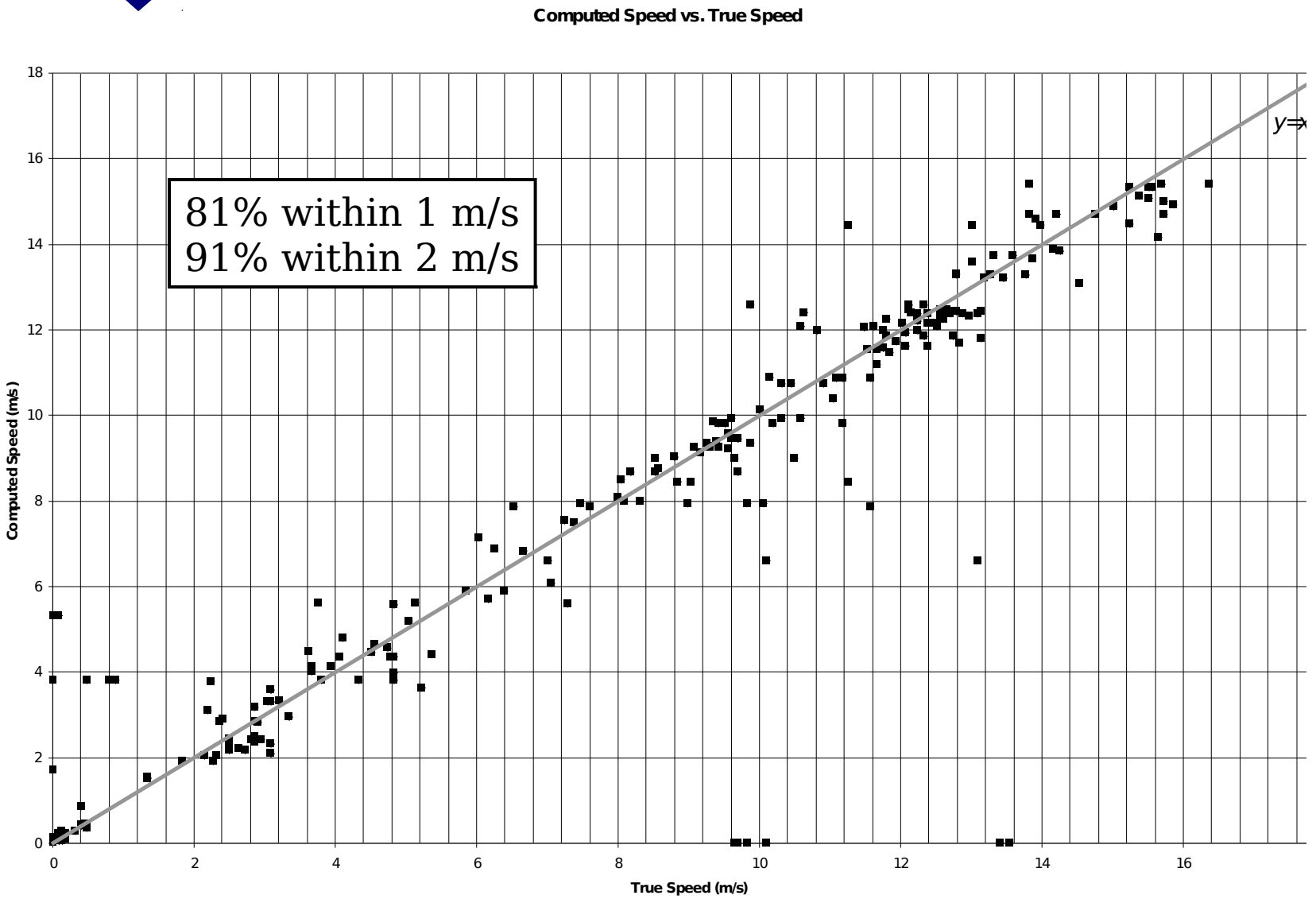
SIF Velocity



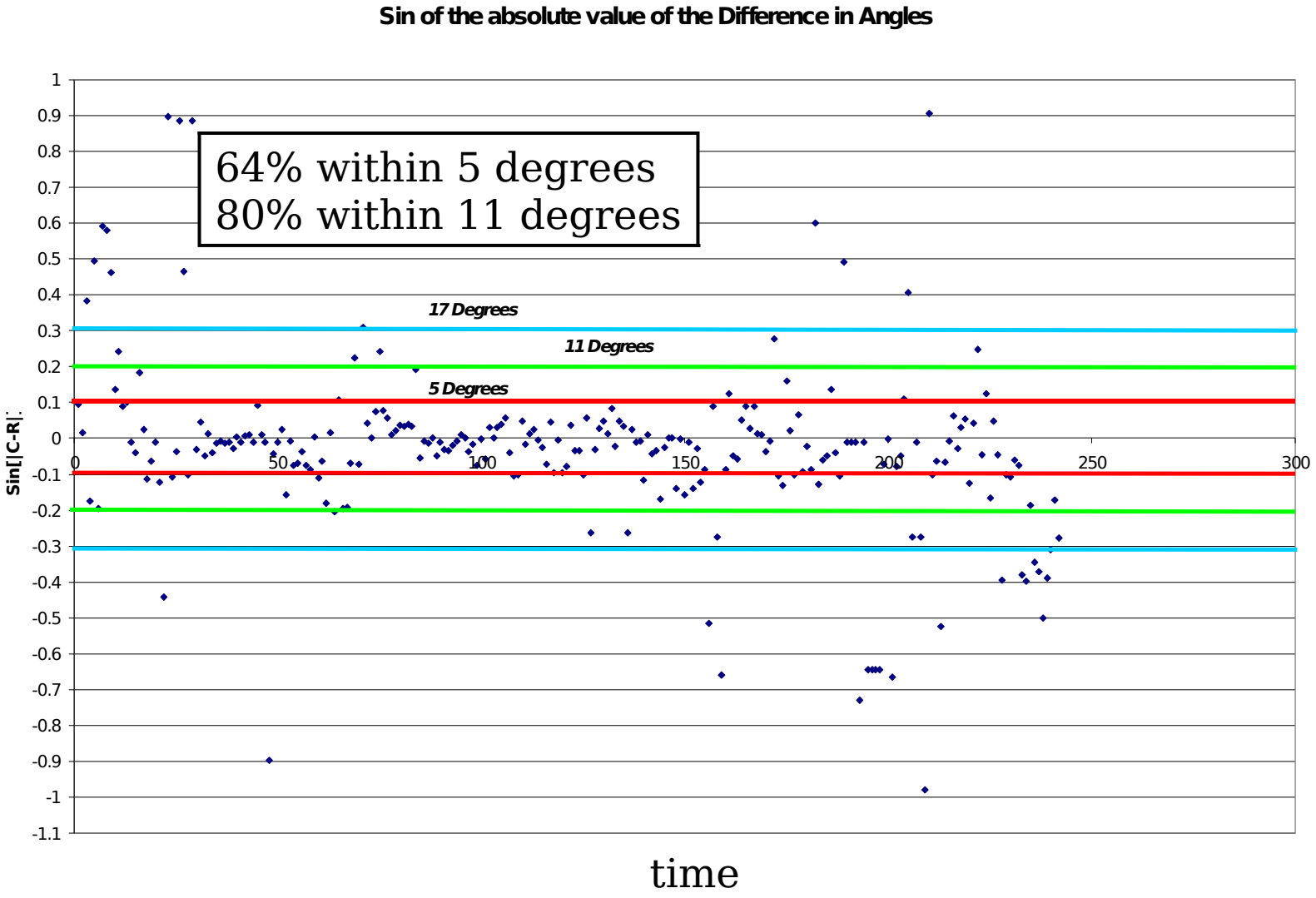
Velocity Results

- We were not able to get valid GPS (ground truth) data for runs using the operational system, which included SIF.
- However other results (R. Brooks) imply that network latencies are not significant in a local area.
- This suggests that our previous results using Sitex ’00 data and assuming no latency, are valid.

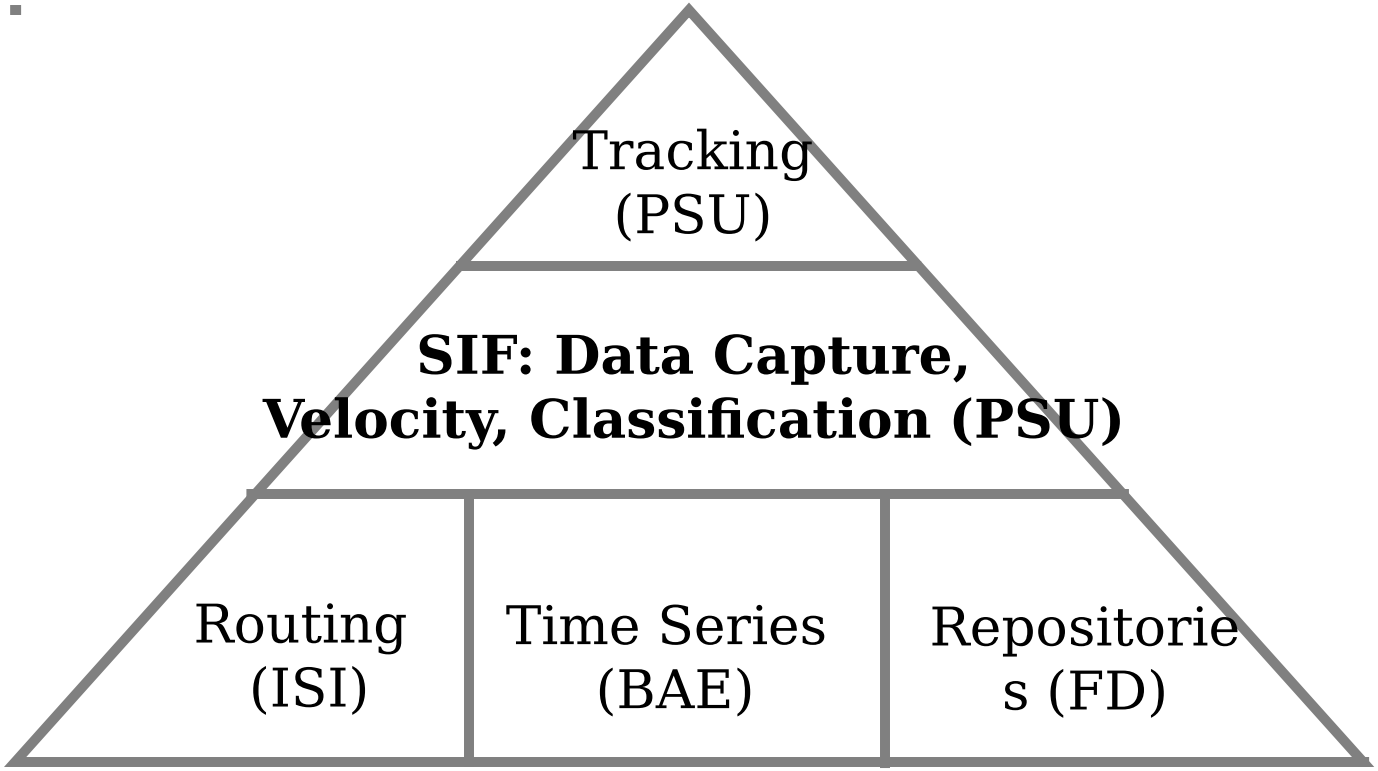
Speed Results (Sitex 00)



Direction Results (Sitex 00)



How SIF fit in the Operational Demonstration



SIF Data Capture

- Motivation
  - A single encapsulated common interface that eliminates the differences between multiple Data API's
- Approach
  - Develop a common, asynchronous API that present a single look and feel to the PSU SensIT Application.

Penn State

Encapsulated Interfaces

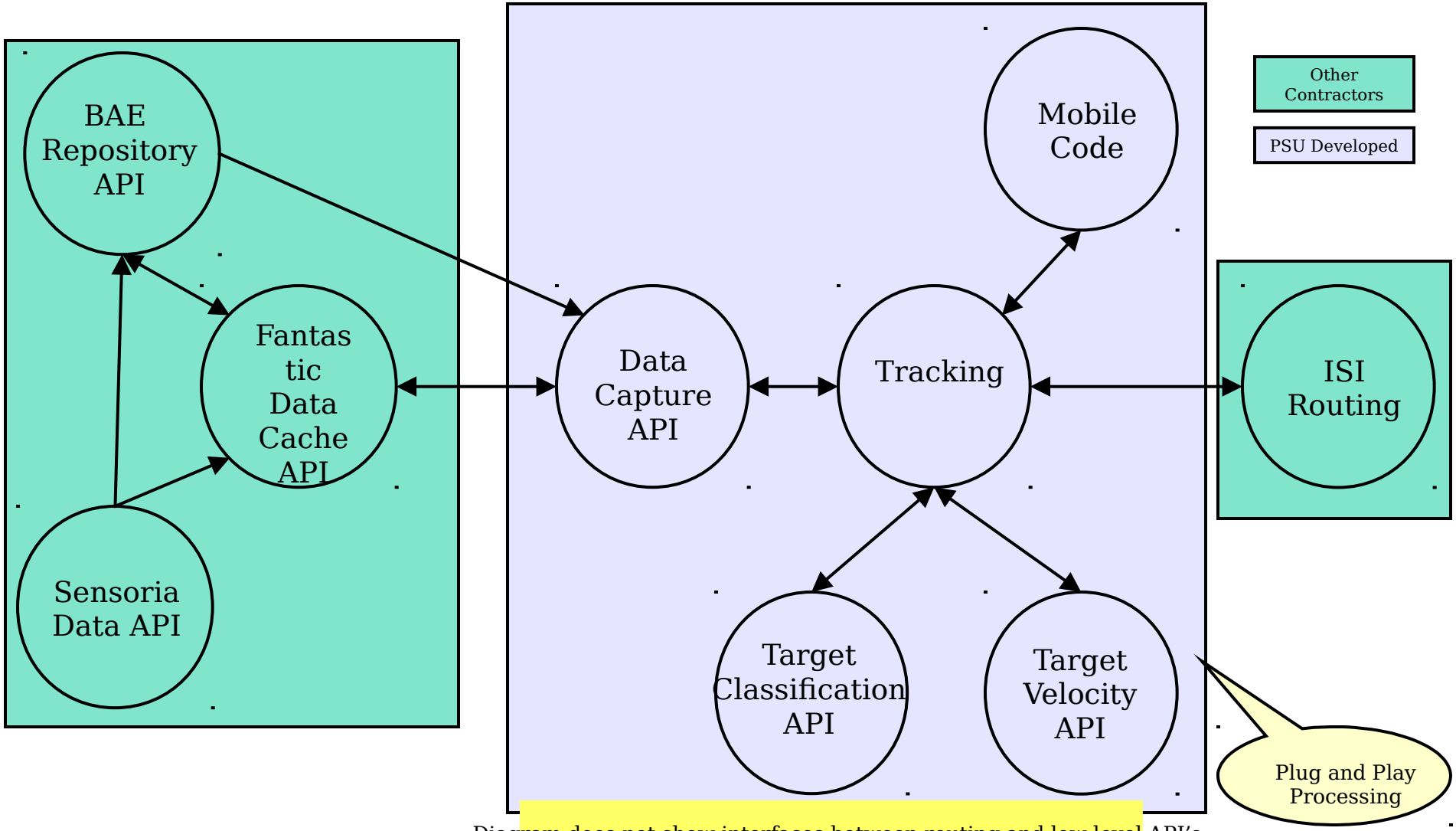


Diagram does not show interfaces between routing and low level API's

Next Steps

1. Verify velocity calculations against SITEX ’02 data
2. Verify classification results against SITEX ’02 data
3. Use SITEX ’02 data to improve methods
4. Participate in SITEX ’03